A Multi-Agent Architecture for Knowledge Management System

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Abstract

With rapid development of the Internet, the original knowledge management systems which are centralized control can not be adaptive to the distributed environment, because there maybe more than one knowledge bases including personal knowledge base in the collaborative environment and involve knowledge in each phase of implement process. Currently, to solve the issue of knowledge management in distributed environment, we use agent and multi-agent technology and propose one distributed knowledge architecture for knowledge management system based on multi-agent. The use of Multi-Agent can increase efficiency of knowledge management and provide intelligence services in collaborative environments via Internet or Intranet.

This paper performs the following tasks: (1) analysis of agent and multi-agent technology; (2) identification, analysis and classification of involved knowledge in collaborative environment or implement process; (3) architecture and characterization of distributed knowledge management system based on multi-agent; (4) introduction of knowledge sharing communication mechanism between agents; (5) conclusion and discussion of the further work.

Keywords: Knowledge Management, Multi-Agent, Knowledge Model, Collaborative Environment

1. Introduction

Since the 21st century, we are in an era of knowledge economy and knowledge-based competition. Knowledge has been considered one of the important resources and precious property, therefore knowledge management (KM) becomes more important to success of all fields. Then, what is the means of KM? Knowledge management mainly concerns using, spreading, sharing, representing and storing of knowledge. But with rapid development of the Internet, the original knowledge management systems which are centralized control can not be adaptive to the distributed environment, especially to collaborative environment which brings geographically dispersed teams together, supporting communication, coordination and cooperation. Collaborative environment could not only support the work, but also achieve a seamless knowledge flow among the collaborative team members. In addition, there maybe exist more than one knowledge bases including personal knowledge base in the collaborative environment and involve knowledge in each phase of implement process. So the distributed management of knowledge is essential and critical. Currently, to solve the issue of knowledge management in distributed environment, we use agent and multi-agent technology and propose the distributed knowledge architecture for knowledge management based on multi-agent. Multi-Agent technology can increase efficiency of knowledge management and provide intelligence services in collaborative environments via Internet or Intranet.

The purposes of this paper are to (a) introduce agent technology and involved knowledge in collaborative environment, (b) present approaches to architecture of distributed knowledge management systems based on multi-agent, (c) discuss knowledge sharing communication mechanism between agents and (d) report the results of research on how we use the popular technology.

The remainder of this paper is organized as follows. Section 2 provides background materials on agent and multi-agent technologies. Section 3 analyses the knowledge process and knowledge classification. Section 4 proposes the architecture of distributed knowledge management based on multi-agent. Section 5 discusses the knowledge share and communication mechanism among agents. The final section summarizes the current work and provides thoughts for future research in the area of knowledge management.

2. Background and Relation Work

2.1. Agent Technology

There are many definitions of what is termed an agent. In a nutshell, an agent can be seen as a software and/or hardware component of system capable of acting exactly in order to accomplish tasks on behalf of its user in some environment (Nwana, 1996). Its characterization includes (1) reactivity; (2) autonomy; (3)
co-operation; (4) reasoning ability; and, (5) knowledge-based.

Agent technology is one of the most promising technologies for dealing with distributed collaborative environment and social interaction in knowledge management. Software agents are being used in an increasingly wide variety of software applications - ranging from comparatively small systems such as personalized assistant to large complex systems such as workflow control. The notable characters make software agents well suited for playing the important role in distributed knowledge management. We believe that agent technology is an appropriate technology to design and develop a distributed system for KM. Ludger vanElst clarified how agent technology meets the KM requirement for definition of agents.

2.2. Multi-Agent System

Multi-agent system (MAS) is widely used to deal with some problems in the complex application environments, especially distributed collaborative environments. MAS are a group of agents that can define their goals and actions, and it integrates these functions to finish a large complex task such as workflow control, knowledge search. Each agent can interact and collaborate with users or other agent through communication for a special problem.

MAS offer a new dimension for cooperation and coordination in distributed collaborative environment. It can provide an effective platform for coordination and cooperation to help the members of team to manage knowledge. Therefore, MAS are best suited for use in open systems such as distributed knowledge management systems with a large and varying number of agents.

3. Analysis and Classification of Knowledge

3.1. Knowledge Management

The definition of knowledge management has different brands. Many studies regard knowledge management as a series of interrelated activities of knowledge identification, acquisition, storage, distribution, reuse, maintenance and development. It views knowledge as a structural resource. Just as with any other resource management, knowledge management aims to provide the proper knowledge in a way of at the right time, at the right place, in the right form, to the right knowledge worker. Therefore, how to capture, manipulate, utilize and the organization. This kind of knowledge includes common sharing resources, enterprise culture and codified intellectual assets such patent, copyrights, trademark and technological know-how. Organization knowledge provides synergistic advantage not replicable share knowledge in distributed collaborative environment has become the crucial problem in knowledge management.

In practice Nissen proposed knowledge management lifecycle model which consists of six phases: create, formalize, organize, distribute, apply and evolve. It shows as Figure 1.

![Knowledge management lifecycle](image)

Figure 1. Knowledge management lifecycle

The knowledge management lifecycle begins with the create phase. Then the new knowledge is formalized and stored as knowledge base according to the knowledge organizing mechanism. When designers require knowledge, they can search and use proper knowledge by accessing knowledge base. Finally knowledge is internalized and further evolved into new knowledge. It also leads in turn to further knowledge creation and completing the lifecycle. There are some cross-points in these near phases of lifecycle. As a whole, the knowledge management lifecycle are also divided into three stages: (1) evolve and create; (2) formalize and organize; (3) disperse and apply.

3.2. Knowledge Classification

There are many kinds of knowledge classifications according to various research fields. In the distributed collaborative environment we mainly classify knowledge into five types: organization knowledge, personal knowledge, domain knowledge, process knowledge, synergy knowledge.

Organization knowledge is the type of knowledge which is relative with organization and is possessed by in the marketplace, and also provides extensive resources for the study and practice of knowledge management.

Personal knowledge is the type of knowledge which is relative with individual and is possessed and managed by individual. It involves in the individual information,
experience and personal knowledge repository such as documents. Personal knowledge plays an important role in dealing with the problem solving.

Domain knowledge is the type of knowledge which involves all expert skills, concepts, relation and other information about a certain domain. Most general, domain knowledge is the knowledge which is valid and directly used for a pre-selected domain of human or an autonomous computer activity. It can describe domain procedure and model the preconditions and effects of domain actions. Domain knowledge is very important to the success of knowledge management and the problem solving.

Process knowledge means the type of knowledge which is relative with business process and can be used by designers when the process is described and executed. Process knowledge contains not only knowledge in describing process information but also knowledge extracted from the information gathered during the process. Process knowledge can support process-related activities efficiently and knowledge-intensive activities in knowledge management.

Synergy knowledge means the type of knowledge which is relative with collaborative design process and implement to carry out and maintain the intra-group or intra-person knowledge exchanges. It also includes some cooperative strategy and technique. It supports communication between all designers. Synergy knowledge is very important in distributed collaborative environment. It can increase design performances and to satisfy the designers’ requirements and to solve the problem.

4. A Multi-Agent Architecture

In this section, we first describe the distributed knowledge model and architecture that is assumed for our distributed knowledge management framework. Then we explain the overall system architecture, followed by the detailed contents of multi-agents. Figure 2 shows the overall architecture of the distributed knowledge management system which is constituted of a set of agents and mainly function modules. These agents are identified by their active roles: serving users, or cooperating work and etc. Each agent is specialized according to its intended roles in the supply chain.

![Figure 2. A multi-agent architecture for knowledge management system](image)

Each agent is autonomous in making decisions on behalf of each function. That is, each agent autonomously collects and processes knowledge information, and cooperate work between these agents according to the practical needs. Share Knowledge Space and Communication Control Center are the main area of knowledge exchange and interaction during the development project.

In this knowledge architecture, there are some agents. These agents are very important for project teams to cooperative design and develop. They are the following agents: Domain Knowledge Agent (DKA), Organization Knowledge Agent (OKA), Process Knowledge Agent (PKA), Distributed Case Base Agent (CBA), Ontology Agent (OA), User Interface Agent (UIA), Workflow Agent (WA) and Toolset Agent (TA).

We give in this paragraph a short description of each agent's role.

- User Interface Agent (UIA) provides the user personal interact management and accesses personal knowledge Base. Each user is associated with a user interface agent, which is responsible for managing and monitoring all user interactions and implementing the level of communication.
necessary for a given user and task combination. They are able to model themselves through learning according to specific user needs and preferences and act autonomously in the collaborative environment.

- Domain Knowledge Agent (DKA) is associated with knowledge base which includes a lot of skill knowledge, expert knowledge and rules in a certain domain. It handles knowledge management activities and can storage, retrieval, maintain and revise according to the ontology library.

- Organization Knowledge Agent (OKA) is associated with repository which includes a lot of common knowledge, organizational management knowledge and rules. It handles knowledge management activities and can make a decision autonomously according to the repository.

- Distributed Case Base Agents (CBA) is responsible for distributed case base management, e.g., storage, retrieval, consistency checking and revision control.

- Process Knowledge Agent (PKA) is responsible for process knowledge management and autonomously deals with process-related activities.

- Ontology Agent (OA) provides basic concept and relation model vocabulary. It can support to describe and search knowledge ontology activities.

- Workflow Agent (WA) mainly provides task management for the users to accomplish the whole project in time. It plays an important role in the collaborative environment.

- Tools Agent (TA): because the system provides a comprehensive set of inter-working tools for efficient team collaboration using www as an information sharing environment, its role is the management of these tools and satisfy the requirements of collaborative teams.

Today multi-agent technology has been widely used in the development of knowledge management system. The intelligent agents are able to tackle specialist problem and can interact with each other within a distributed environment. So the use of agents and multi-agent technologies in knowledge management systems is necessary and effective.

5. Knowledge Sharing Mechanism between Agents

MAS consist of a group of agents. Communication is considered as the most important element in MAS. In order to achieve effective interaction, each agent must have a mechanism to ensure that it reaches an agreement. In this paper, we use knowledge ontology to define a common vocabulary for agents to communicate with one another, and explicitly formalize the domain knowledge about primitive concepts, relations, rules and their instances.

The communication of MAS not only transfer message, but also transfer belief, desire, intention and other minds. There are four layers: the communication layer, message layer, mind layer and application layer. It shows as Figure 3.

![Figure 3. Knowledge sharing mechanism](image)

The application layer indicates the actual content of interaction based on knowledge ontology. The mind layer involves belief, desire and intention except content. The message layer includes content codes, expressions and so on. It uses common communication language format. The communication layer is the bottom layer. It encodes the low-level communication features that describe some parameters, such as the sender and the receiver. In additional, this layer also considered the safety and reliable communication.

6. Conclusion and Future Work

In this paper we introduce agent technology and analyse involved knowledge for knowledge management in distributed collaborative environment. Then we propose the model and architecture for distributed knowledge management based on multi-agent. We discuss the knowledge sharing communication mechanism between agents. Of course, at present we finish the basic research work. In the future, we plan to implement this prototype system and use it in some projects development. In addition, we are currently working on integrating new technology into the distributed knowledge management system, such as integrating a lot of tools and techniques with the semantic web.
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